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ABSTRACT

This digest contains four sections that discuss the following broad principles that offer a framework to teachers for thinking about how technology can support their instruction: (1) learning occurs in context, including ways that technology can facilitate learning by providing real world contexts that engage learners in solving complex problems, and computer simulations and computer-based microworlds that offer contexts for learners to explore and understand complex phenomena in a variety of subject areas; (2) learning is active, including the use of brainstorming, concept mapping, or visualization software, as well as simulations that enable learners to experiment with modeling complex ideas; (3) learning is social, including software that supports a networked, multimedia environment in which students collaborate on learning activities; and (4) learning is reflective, including technologies that promote communication within and outside the classroom, making it easier for feedback, reflection, and revision to occur. (Contains 15 references.) (MES)

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How People Learn (and What Technology Might Have to Do with It)

By Marcy P. Driscoll

At an educational conference last spring, I attended a session focused on the potential of instructional technology to transform teaching and learning in schools. One of the speakers told a story about his 14-year-old son who, like himself, loved technology toys and always had to have the latest and greatest new thing to come on the market. One day, this son went to school after downloading to his Palm Pilot™ the program from the TV remote control. Then in one of his classes, the boy used the program to turn on and off the television in the corner of the room. The teacher was understandably annoyed, and when she figured out who the culprit was, she hauled him off to the principal's office demanding that the principal "do something!" At this point in the story, the speaker paused and asked the audience to consider what an appropriate response by the principal might be. Surely, this was a teachable moment, for teacher and student. Although many of us are regular users of Personal Digital Assistants (PDAs), we are only beginning to imagine how the technology might be used in the service of teaching and learning. So what did the principal do? He banned it!

I offer this story not to malign the principal, but to argue that technology integration in schools is not easy to achieve, no matter how much evidence we have that it can help learning. It's also important to integrate technology appropriately, as critics are quick to point out that computers, besides being expensive, can harm young children who sit for hours in front of them instead of being engaged in the "real world" (Alliance for Childhood, 2000). So what *is* known about how people learn and the role technology may play in their learning? How might that knowledge provide guidelines for appropriate uses of technology that can help students and teachers? Four broad principles offer a framework to teachers for thinking about how technology can support their instruction:

- Learning occurs in context.
- Learning is active.
- Learning is social.
- Learning is reflective.

Learning Occurs in Context

Read the following sentence: "The notes were sour because the seams split." What does it mean? Chances are that you found the sentence confusing, even though all the words are common and familiar. Now consider that the sentence is describing bagpipes and read it again. I suspect it makes much better sense now. Without an appropriate context, comprehension and learning are difficult and unlikely to succeed very well. Keep in mind, however, that learners will attempt to make sense of anything unfamiliar, just as you attempted to make sense of that sentence. When they do so, they draw upon prior understandings and experience, but the meanings they construct may be quite different from what was intended if they cannot activate an appropriate context for learning. "Children are ignorant but not stupid: Young children lack knowledge, but they do have abilities to reason with the knowledge they understand" (National Research Council, 2000, p. 234).

Technology can facilitate learning by providing real world contexts that engage learners in solving complex problems (Duffy & Cunningham, 1996; Honebein, 1996; & Cognition and Technology Group at Vanderbilt, 1992). *The Jasper Woodbury Problem Solving Series* (Cognition and Technology Group at Vanderbilt, 1997), for example, is an interactive video environment that presents mathematical problems through the adventures of a boy named Jasper. In each episode, Jasper faces a challenge, such as figuring out how much fuel is needed to fly an ultra-light aircraft into a remote area to rescue a stranded eagle. Students must apply important concepts in mathematics to solve Jasper's challenge. Because the video adventures are interesting, students are drawn into them. Because the challenges are complex, students engage in problem solving for extended periods of time. And because the episodes are designed to be sequential and build upon previously acquired skills, students learn to transfer what they know to new and unfamiliar problems.

Computer simulations and computer-based microworlds also offer appropriate contexts for learners to explore and come to understand complex phenomena in a variety of subject areas (Rieber, 1996). For example, the popular *SimCity* enables learners to explore what it's like to build and manage aspects of a city, and with the *Voyage of the Mimi*, students can explore sea life and solve problems while learning about whales.

Learning Is Active

Tell me, I forget.
Show me, I remember.
Involve me, I understand.

—Chinese proverb

This proverb illustrates well the importance of getting learners mentally involved in learning activities, generating connections between what they already know and what they are being asked to learn and constructing meaning from their experiences. When students become active participants in the knowledge construction process, the focus of learning shifts from covering the curriculum to working with ideas (Scardamalia, 2002). And using technology tools "to think with" facilitates working with ideas and learning from that process.

Technology tools provide "the means through which individuals engage and manipulate both resources and their own ideas" (Hannafin, Land, & Oliver, 1999, p. 128). Some kinds of technology tools can extend memory and make thinking visible. Good examples include brainstorming and concept mapping software such as Inspiration®. Others help to represent knowledge and facilitate communication. For instance, the Collaborative Visualization or CoVis Project provides visualization software designed to help students collect and analyze climatological data and visualize effects due to greenhouse gases and other phenomena (e.g., Pea et al., 1997). Finally, some tools, like simulations mentioned above, enable learners to experiment with modeling complex ideas. NetLogo, for example, provides a programmable modeling environment for simulating natural and social phenomena, such as how segregated neighborhoods can arise, not from any specific bias, but from the simple desire of people to live near others who are like themselves.

Learning Is Social

Teachers have long recognized the value of having students work together in a group to accomplish some types of learning tasks. Students benefit from hearing perspectives other than their own, and they may bring different strengths to a complex and lengthy activity. However, a social theory of learning reflects a fundamentally different view, where knowledge "is a matter of competence with respect to valued enterprises" and knowing "is a matter of participating in the pursuit of such enterprises" (Wenger, 1998, p. 4). Learning, then, amounts to increasing participation in and contribution to the practices of a social community. Concepts such as knowledge building, apprenticeship, and mentoring become paramount, as learners are conceived to be under the tutelage of more experienced peers or instructors.

A social view of learning focuses attention on making connections among students within a school and between students in the school and the broader community. How can modern technologies support and enhance these connections?

CSILE (or Computer-Supported Intentional Learning Environment; Scardamalia & Bereiter, 1994) is one example of software that supports a networked, multimedia environment in which students collaborate on learning activities. They do this by creating 'notes' to express their ideas or integrate outside information about a topic. Then they read and respond to the notes of others, all of which builds a communal database producing shared knowledge about the topic or problem.

The effects of CSILE have been notably positive, with students performing better on standardized tests than their non-CSILE counterparts. CSILE students also demonstrate greater depth in their explanations. At a conference reporting some of the CSILE findings, Marlene Scardamalia read a few notes posted in one class's database and challenged the audience to determine who wrote them – a fourth grader, a college student, or a scientist. I sat in the back of the auditorium and watched most of the hands go up as people thought the notes must have been written by at least a college student, if not a scientist. In all cases, however, the notes were written by fourth grade students in response to the notes and questions of their peers.

With migration to the Internet, CSILE, now known as Knowledge Forum, facilitates connections between schools and the scientific community, allowing practicing scientists to serve as mentors to students. Other projects, such as Kids as Global Scientists, also bring students and various experts together in virtual communities through Internet links. Such "a dialogue-based approach to learning creates a rich intellectual context, with ample opportunities for participants to improve their understanding and become more personally involved in explaining scientific phenomena" (National Research Council, 2000, p. 226).

Learning Is Reflective

In one of the graduate courses I teach on emerging theories of learning, I want students to experience the implications of the ideas they are studying. Thus, they might be required to work in a group, participate in a class project, contribute to a knowledge-building enterprise, and so on. Several times during the semester, I ask students to reflect on their own learning, the functioning of their group, and the operation of the class. A few years ago, early in the semester, students complained so much about aspects of the course that I brought up the issues in class (usually their reflections are confidential and sent to me by e-mail). One individual who was a fifth grade teacher said, "Cooperative learning is fine for kids. But I'm an adult! My learning shouldn't have to depend on anyone else." As we discussed further how others felt about learning in a group, the same individual spoke up again, this time rather bemused. She said, "Maybe I'm reacting the same way my fifth graders do when I try something new with them." It was an important insight for her that was prompted by deliberate reflection of the class on what it means and feels like to work in a learning group.

Learning is facilitated when students get feedback about their thinking, whether that feedback comes from within, a teacher, or a peer. Then provided the opportunity for revision, students can achieve at higher levels and reach deeper understandings. Technologies that promote communication within and outside the classroom make it easier for feedback, reflection, and revision to occur. Many of the technology examples presented above facilitate reflection in the dialogue that they promote among learners. Where dialogue or discussion is not inherent in the tool, teachers bear the responsibility of initiating and guiding it.

A Few Parting Thoughts

Technology by itself does not guarantee learning. Rather, it is in how teachers and students use available technologies that determines whether transformative learning happens. Educators can respond to the challenge like the principal who banned PDAs from his school. Or they can explore the power of technology to help learners achieve important outcomes. Understanding principles of learning is a good way to begin.

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